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ABSTRACT

A study examined gender differences in stereotypes, experience, and confidence for computer science (CS) first-year students. Questionnaires were distributed to freshmen students (n=241: 161 females, 80 males) in a required university seminar course. Overall, participants possessed very stereotypical attitudes of CS majors. Findings showed that men reported having more experience with computers than did women, and they also enjoyed working with computers more than did women. (Contains 27 references, 1 table, and 1 figure.) (Author/BT)

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Why are There so Few Women in Computer Science?[1]

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Abstract

We examined gender differences in stereotypes, experience and confidence in Computer Science (CS) in first-year students. Overall, participants possessed very stereotypical attitudes about CS majors. Men reported having more experience with computers and reported more computer confidence than did women. Men also enjoyed working with computers more than did women.

This nation faces a serious shortage of computer scientists. From 1986 to 1996, the number of men majoring in Computer Science (CS) dropped by 33%, whereas the number of women dropped by 55% (calculated from data in U.S. Department of Education, 2000). This shortage of computer scientists provides a major impetus for increasing the representation of women in CS.

Two reasons for the small number of women in CS are negative attitudes towards the field and low confidence. Beyer (1990, 1998, 1999b, 2002; Beyer & Bowden, 1997; Beyer, Chavez, & Rynes, 2002; Beyer, Riesselmann, & Warren, 2002) has repeatedly found that females have inaccurately low confidence in masculine domains, including mathematics, chemistry, and CS.

CS is stereotyped as even more male-dominated than the traditional male bastions of chemistry and mathematics (Beyer, 1999a). Both males and females *incorrectly* believe that males in CS have higher GPAs than females (Beyer, 1999a). Furthermore, those women who do succeed in CS are often viewed as "exceptional", leaving the stereotype that women do not belong in CS intact (Henwood, 1999/2000).

The stereotypes about CS majors are unflattering. They are perceived to be intelligent but deficient in interpersonal skills (Beyer, 1999a; Beyer, Chavez, & Rynes, 2002). This has been termed the "computer nerd syndrome" or "geek mythology" (Margolis & Fisher, 1997; Rasmussen & Hapnes, 1991). These perceptions of CS majors conflict more with the gender roles of females than of males, because women tend to have a stronger interpersonal orientation than men (Cross & Madson, 1997; Markus & Kitayama, 1991).

The major goal of the present research is to discover the barriers that discourage undergraduate women from taking courses in CS. To this end we examine gender differences in attitudes and confidence in CS in first-year students.

Method

We distributed questionnaires to 241 first-year students (161 females, 80 males) in a required University Seminar course. Participants were paid. Participants filled out questionnaires assessing demographic and family background information; ability and preparation in quantitative areas; educational goals and interests (Farmer, Wardrop, Anderson,& Risinger, 1995; Lips, 1992); experience with and attitudes towards computers (Lips, 1992); stereotypes and knowledge about CS; confidence (Nickell & Pinto, 1986); interpersonal relations (Cross, Bacon, & Morris, 2000; Cutrona & Russell, 1984); family orientation (Ethington & Wolfle, 1988); personality attributes (e.g., self-esteem [Rosenberg, 1965], gender roles [Bem, 1974], and the Big 5 [John & Robins, 1993]); stress (Cohen, Kamarck,& Mermelstein, 1983); financial and family issues; and attitudes towards any CS courses and instructors they had had.

Results

2 (gender) x 2 (semester group: students surveyed in fall versus spring 2001) analyses of variance (ANOVAs) were calculated. Gender did not interact with the semester group variable, so only the results for gender will be presented. Selected means and standard deviations can be found in Table 1.

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TABLE 1: Means and Standard Deviations for Selected Dependent Variables.

	Females		Males	
	Mean	(SD)	Mean	(SD)
High school GPA	3.21**	(.51)	3.00**	(.58)
Educational aspirations	2.34*	(1.24)	2.00*	(1.14)
Computer enjoyment	4.00**	(1.50)	4.59**	(1.42)
Interest in CS	4.95****	(1.63)	3.91****	(1.95)
Computer scientist salary	$48355*	(18149)	$54294*	(23092)
Difficulty of CS careers	3.53*	(1.13)	3.85*	(1.06)
Perceived ability in CS	3.35****	(1.55)	4.81****	(1.85)

NOTE: *$p < .05$, **$p < .01$, ***$p < .001$, ****$p < .0001$

Demographic Variables

There was no significant gender difference in age, $F(1, 236) < 1$. The average age of our participants was 20. Male and female students were remarkably similar in terms of demographic variables including age, race, number of siblings, year in college, marital status, number of children, prevalence of disabilities, socioeconomic status while growing up, and parental level of education. However, women had attended significantly more semesters at this university than men had, $F(1, 209) = 5.32$, $p < .05$.

Ability and Preparation in Quantitative Areas

Women reported higher high school GPAs than men did, $F(1, 225) = 8.25$, $p < .01$.

Educational Goals and Interests

Women had significantly higher educational aspirations than did men, $F(1, 232) = 4.24$, $p < .05$. Men were significantly more likely to plan to take more math and science courses than were women, $F(1, 236) = 11.70$, $p < .01$. In terms of selecting a career, women rated intrinsic satisfaction, $F(1, 233) = 12.72$, $p < .0001$, and interactions with people to be significantly more important than did men, $F(1, 232) = 7.05$, $p < .01$. Interestingly, career concerns were less salient for men than for women, $F(1, 236) = 11.44$, $p < .001$.

Previous Experience with and Attitude towards Computers

More women (85.4%) than men (73.7%) reported owning a computer, $F(1, 231) = 5.03$, $p < .05$. There was no gender difference regarding the age at first computer use, $F(1, 232) < 1$.

Significantly more men (35%) than women (19%) had experience in computer programming, $F(1, 235) = 9.19$, $p < .05$. Men were significantly more likely to have taken a computer apart, $F(1, 235) = 26.24$, $p < .0001$, and to have installed internal components such as RAM into a computer than were women, $F(1, 234) = 17.41$, $p < .0001$. They also enjoyed working with computers more, $F(1, 234) = 8.50$, $p < .01$, and reported significantly more interest in the Computer Science major than did women, $F(1, 214) = 17.90$, $p < .0001$. Women had less anxiety about the potential harm of computers to humanity than did men, $F(1, 234) = 9.59$, $p < .01$.

Stereotypes and Knowledge about CS

There were no gender differences in the stereotypes that participants held toward CS majors. Overall participants thought that CS majors are asocial, unathletic, good at math and science, hard-working, and intelligent.

There was no gender difference in knowledge of what CS is, $F(1, 235) < 1$. Men estimated the starting salary of a computer scientist significantly more highly than did women, $F(1, 216) = 4.24$, $p < .05$. Both males and females rated the career opportunities of individuals with CS degrees as excellent.

We asked questions regarding CS as a career for parents of young children. Participants indicated that it would be a good career because of high income and the ability to work from home, but simultaneously thought the high level of stress and amount of travel required would be difficult for parents of young children. Participants did not view CS as a field where success and raising a family are incompatible goals. Men thought that careers in CS were more difficult than women thought they were, $F(1, 234) = 5.16$, $p < .02$.

Confidence

Confidence in computer skills was regressed on gender, mathematics ACT score, and their interaction. A significant interaction between gender and math ACT score was found, $F(1, 191) = 7.64$, $p < .006$. As Figure 1 clearly illustrates, women's confidence in their computer abilities was not affected by their math ACT score. In contrast, men's confidence was greatly affected by their math ACT score, as higher ACT scores yielded higher confidence in computer abilities. Men also reported having more CS ability than women did, $F(1, 235) = 13.31$, $p < .0001$.

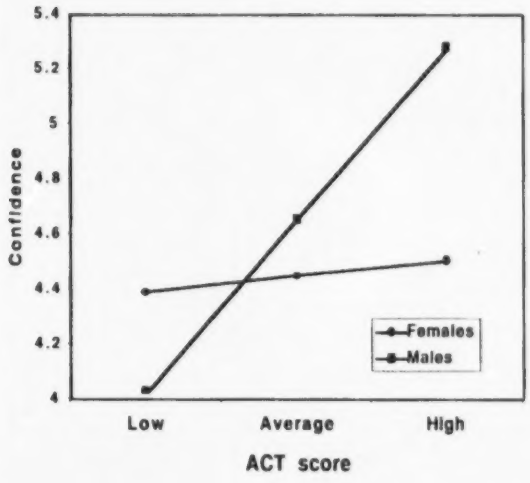

Figure 1: Gender Differences in Confidence by Math ACT Score.

Personality Variables

Women scored significantly higher than men in conscientiousness, $F(1, 232) = 4.18$, $p < .05$, and neuroticism, $F(1, 232) = 10.48$, $p < .01$. As expected, men were more often classified as "masculine", $F(1, 235) = 12.00$, $p < .001$, and women as "feminine", $F(1, 235) = 16.37$, $p < .0001$, according to the Bem Sex Role Inventory (Bem, 1974). Women reported more interpersonal attachment, $F(1, 235) = 17.06$, $p < .0001$, and greater family orientation than men, $F(1, 236) = 7.89$, $p < .01$.

Stress and Financial Issues

Women reported experiencing significantly more stress than did men, $F(1, 236) = 5.87$, $p < .05$. More women (68.8%) than men (51.3%) were employed at the time of the survey, $F(1, 235) = 6.96$, $p < .01$. However, men reported more work hours than women did, $F(1, 143) = 4.48$, $p < .05$. There were no differences in financial responsibilities, $F(1, 235) < 1$, or certainty of having adequate financial support to finish college, $F(1, 234) < 1$.

Discussion

This research found that first-year students hold stereotypes regarding CS. Participants described the typical CS major as asocial, unathletic, but intelligent. The stereotypes of CS majors as "nerds", their perceived obsession with machines and lack of interest in people, and associations of technology with masculinity conflict with the gender roles of females (Cross & Madson, 1997; Markus & Kitayama, 1991). Indeed, our first-year undergraduate women were significantly more feminine and less masculine than their male counterparts. Coupled with the stereotypical but inaccurate perception of women's lower ability in CS (Beyer, 1999a), these stereotypes probably conspire to deter first-year women from taking CS classes.

The gender difference in computer confidence is of concern. Importantly, women's low confidence in CS is not due to a lack of quantitative ability. The gender difference in confidence persists even when math ACT score is controlled. It is interesting to note that a similar gender difference in confidence was found for CS students as well (Beyer, Chavez, & Rynes, 2002).

One cause of women's low confidence is their less playful and relaxed attitude towards computers (Rasmussen & Hapnes, 1991). This is exemplified in this study by men's greater likelihood to have taken a computer apart and their reports of greater enjoyment of working with computers. Confidence is also affected by the amount of previous experience with computers (Zubrow, 1987). The fact that our first-year women had less programming experience might negatively affect their confidence.

What is the consequence of low confidence? Positive self-perceptions of ability are intimately tied to aspirations, educational choices, preference for challenging tasks, intrinsic motivation, persistence, and thus have desirable effects on performance (for a review see Beyer, 1995). Indeed, high performance expectations are a better predictor of mathematics participation and of continued high confidence for the future than are grades (Beyer, 1999b; Lantz & Smith, 1981). This suggests that females' low computer confidence has deleterious behavioral consequences. Importantly, low confidence may decrease the likelihood that women will choose to take CS courses. This means that women miss the opportunity to enter into a highly-paid field with excellent career potential.

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